भारतीय मानक
Indian Standard

IS 1199 (Part 3) : 2018

ताजा कंक्रीट — नमूने लेना, परीक्षण एवं विश्लेषण पद्धतियाँ

भाग 3 ताजा कंक्रीट के घनत्व का निर्धारण

(पहला पुनरीक्षण)

Fresh Concrete — Methods of Sampling, Testing and Analysis

Part 3 Determination of Density of Fresh Concrete

(First Revision)

ICS 91.100.30

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Cement and Concrete Sectional Committee, CED 02

FOREWORD

This Indian Standard (Part 3) (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Cement and Concrete Sectional Committee had been approved by the Civil Engineering Division Council.

Testing plays an important role in controlling the quality of cement concrete work. Systematic testing of the raw materials, the fresh concrete and the hardened concrete, is an inseparable part of any quality control programme for concrete. This helps achieve a higher efficiency of the materials used and greater assurance of the performance of the concrete, in regard to workability, strength and durability. The test methods used should be simple, direct and convenient to apply. This standard was formulated with this objective in view.

This standard was first published in 1959. In this revision, it was decided to review and update the various existing test methods of fresh concrete taking into consideration the latest international practices and developments in this field in the country, and also introduced certain new test methods, wherever required. In the process, the various existing test methods covered in IS 1199 : 1959 'Methods of sampling and analysis of concrete', have been revised. The revision of the standard is being brought out taking into consideration primarily the corresponding ISO Standards while also examining the other best practices world over and in the country. In addition, test methods for determination of properties of new types of concrete like self compacting concrete have been included, covering tests such as consistency, viscosity, passing ability and segregation resistance. Also, for better understanding and implementation, some of the other test methods which were spread over in other Indian Standards have been brought together under the fold of IS 1199 as its various parts, such as the setting time of concrete by penetration method and, water soluble and acid soluble chlorides in mortar and concrete. This is with a view to making the standard complete in all respects, and rendering it a comprehensive source of provisions for testing of concrete and reference in other Indian Standards.

In this revision, IS 1199 has been split into nine parts. The other parts in the series are:

Part 1 Sampling of fresh concrete

Part 2 Determination of consistency of fresh concrete

Part 4 Determination of air content of fresh concrete

Part 5 Making and curing of test specimens

Part 6 Tests on fresh self compacting concrete

Part 7 Determination of setting time of concrete by penetration resistance

Part 8 Determination of water soluble and acid soluble chlorides in mortar and concrete

Part 9 Analysis of freshly mixed concrete

This standard (Part 3) covers the procedures for determination of density of fresh concrete.

These test methods shall be applicable as and when published in place of the corresponding provisions given in IS 1199 : 1959. IS 1199 : 1959 shall be superseded after the publication of all the parts of the standard.

This revision of the standard has been taken up to incorporate the modifications found necessary in the light of experience gained in its use and also to bring it in line with the latest development on the subject. Significant provisions in this revision are highlighted below:

a) Calculation of cement factor and air content have been deleted from this revision, as they are purely theoretical in nature.
b) Details on compaction equipment have been covered.

(*Continued on third cover*)

Indian Standard

FRESH CONCRETE — METHODS OF SAMPLING, TESTING AND ANALYSIS

PART 3 DETERMINATION OF DENSITY OF FRESH CONCRETE

(First Revision)

1 SCOPE

This standard (Part 3) specifies procedures for determination of density of fresh concrete. It also gives the calculation of volume of concrete per batch, and yield per bag of cement.

2 REFERENCES

The standards listed in Annex A contain provisions, which through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated in Annex A.

3 TERMINOLOGY

For the purpose of this standard, the definitions given in IS 4845, IS 6461 (Parts 1 to 12) and the following shall apply.

3.1 Density of Fresh Concrete — The mass of a quantity of fully compacted fresh concrete divided by its volume, expressed in kg/m^3.

4 DETERMINATION OF DENSITY OF FRESH CONCRETE

4.1 Principle

The fresh concrete is compacted into a calibrated rigid and watertight container and is then weighed. This test method may not be applicable to aerated concrete or very stiff concrete that cannot be compacted by normal vibration and care is needed in its use with these concretes.

4.2 Apparatus

4.2.1 *Container,* water tight and sufficiently rigid container, made of metal and not readily attacked by cement paste, having a smooth internal face, with the rim machined to a plane surface shall be used.

The rim and the base shall be parallel. The smallest dimension of the internal diameter and the height of the container shall be at least four times the maximum aggregate size in concrete but shall be not less than 150 mm. The volume of the container shall not be less than 5 litre. The ratio of the diameter to the height of the container shall be $1.25 > d_c/h_c > 0.5$. The measure shall conform to one of the sizes given in Table 1. The larger size container given in Table 1 may be suitable for the nominal size of aggregates up to 80 mm, for still larger sizes of aggregates, bigger containers may be used. Such containers shall be as per the guidelines given above.

The containers shall be calibrated in accordance with Annex B to obtain the volume (V) of the container. The containers shall be in calibration at time of use. The frequency of the calibration shall not be less than once in a year.

Table 1 Dimensional Requirements for Cylindrical Container Used for Measuring Density of Fresh Concrete

(*Clause* 4.2.1)

Sl No.	Nominal Size of Coarse Aggregate	Inside Diameter	Inside Height	Minimum Thickness of Metal
(1)	(2)	(3)	(4)	(5)
i)	Up to 40	250	280	4
ii)	Above 40	350	285	5

4.2.2 *Filling Frame* (*Optional*), made of metal not readily attacked by cement paste, fitted tightly to the container.

4.2.3 Concrete placed in the container shall be compacted with one of the following:

a) *Internal vibrator,* with a minimum frequency of 120 Hz (7 200 cycles/min). The vibrator shall meet the requirements of IS 2505.

b) *Vibrating table,* with a minimum frequency of 50 Hz (3 000 cycles/min). The vibrating table shall meet the requirements of IS 2514.

c) *Compacting rod,* of circular cross-section, straight, made of steel, having a diameter of 16 ±1 mm, a length of 600 ± 5 mm and shall have rounded ends.

d) *Compacting bar,* of square or round cross-section with mass greater than 1.8 kg for hand compacting.

4.2.4 *Balance or Scale* — It shall be capable of determining the mass of the compacted concrete to an accuracy of 0.1 percent of the mass of the concrete.

4.2.5 *Straight-Edged Scraper* — It shall be made of steel and shall be minimum 100 mm more than the maximum internal dimensions of the top of the container.

4.2.6 *Shovel,* of appropriate size.

4.2.7 *Remixing Tray* — It shall be of rigid construction and made from a non-absorbent material not readily attacked by the cement paste. The tray shall be of appropriate dimensions such that the concrete can be thoroughly remixed using the square mouthed shovel.

4.2.8 *Trowel,* approximately 100 mm wide.

4.2.9 *Steel Float*

4.2.10 *Mallet*

4.3 Sampling

The sample for the test shall be obtained in accordance with IS 1199 (Part 1). The sample shall be properly mixed before carrying out the test.

NOTES

1 When carrying out this test, prevent skin contact with fresh concrete by wearing suitable protective clothing, gloves and footwear. If wet cement or concrete enters the eye, immediately wash it out thoroughly with clean water and seek medical treatment without delay. Wash fresh concrete off the skin immediately.

2 The use of vibrating equipment, such as vibrating tables, can cause damage to joints and loss of sensation due to nerve damage. Moulds, etc, shall be clamped to the table and not held in position using one's hand while they are being vibrated.

4.4 Procedure

4.4.1 *Mass of the Container*

Weigh the container to determine its mass m_1, and record the value indicated.

4.4.2 *Filling the Container*

If a filling frame is used, ensure that the amount of concrete used to fill the container is such that a layer of concrete remains in the filling frame after compaction, with a thickness of 10 percent to 20 percent of the height of the container. Fill the concrete in a minimum of two layers.

4.4.3 *Compacting the Concrete*

4.4.3.1 *General*

Compact the concrete immediately after placing it in the container in such a way as to produce full compaction of the concrete, with neither excessive segregation nor laitance. Compact each layer by using one of the methods described in **4.4.3.2** or **4.4.3.3**.

NOTES

1 Using mechanical vibration, full compaction is achieved when there is no further appearance of large air bubbles on the surface of the concrete and the surface becomes relatively smooth with a glazed appearance, without excessive segregation.

2 To produce full compaction by hand, the number of strokes per layer required will depend upon the consistence of the concrete.

4.4.3.2 *Mechanical vibration*

4.4.3.2.1 *Compaction with internal vibrator*

Apply the vibration for the minimum duration necessary to achieve full compaction of the concrete. Avoid over vibration which may cause loss of entrained air. Care shall be taken not to damage the container. The use of filling frame is recommended.

NOTE — Laboratory tests have shown that great care is needed, if loss of entrained air is to be avoided when using an internal vibrator.

Ensure that the vibrator is kept vertical and not allowed to touch the bottom or sides of the container.

4.4.3.2.2 *Compacting with vibrating table*

Apply the vibration for the minimum duration necessary to achieve full compaction of the concrete. The container should be attached firmly to the table. The vibration can be stopped when no more concrete gets compacted with no laitance on the surface. Avoid over vibration, which may cause loss of entrained air.

4.4.3.3 *Hand compaction with compacting rod or bar*

Distribute the strokes of the compacting rod or bar in a uniform manner over the cross-section of the mould. Ensure that the compacting rod or bar does not forcibly strike the bottom of the container when compacting the first layer, nor penetrate significantly any previous layers. Subject the concrete to at least 25 strokes per layer. In order to remove the pockets of entrapped air but not the entrained air, after the compaction of each layer, tap the sides of the container smartly with the mallet until large bubbles of air cease to appear on the surface and depressions left by the compacting rod or bar are removed.

4.4.4 *Surface Levelling*

After the top layer has been compacted, smooth level with the top of the container using the steel float. Skim the surface and rim with the straight edge and wipe clean the outside of the container.

4.4.5 *Determining the Mass and Volume of the Container*

Weigh the container with its contents to determine its

weight (m_2) and record the value indicated. The volume, V, of the container shall be determined in accordance with Annex B.

4.5 Test Results

The density is calculated from the equation:

$$\rho_{fr} = (m_2 - m_1)/V$$

where

ρ_{fr} = density of the fresh concrete, in kg/m^3;

m_1 = mass of the container, in kg;

m_2 = mass of the container including the concrete in the container, in kg; and

V = volume of the container, in m^3.

The density of the concrete shall be expressed to the nearest 10 kg/m^3.

4.6 Additional Calculations for the Density Test (Determination of Volume of Concrete per Batch)

4.6.1 *General*

Once the density of the compacted fresh concrete has been determined, it is possible to use the results to calculate,

a) volume of concrete per batch; and

b) yield per bag of cement.

4.6.2 *Calculation of Volume of Concrete per Batch*

The volume of concrete produced per batch shall be calculated from the following equation:

$$V_b = \frac{m_T}{\rho_{fr,c}}$$

where

V_b = volume of concrete produced per batch, in m^3;

m_T = sum of masses of all the constituents of the concrete as batched, in kg; and

$\rho_{fr,c}$ = density of the fully compacted concrete, in kg/m^3.

The results shall be expressed to an accuracy of third decimal digit.

4.6.3 *Yield per Bag of Cement*

The yield shall be calculated as follows:

$$Y = V/N$$

where

Y = yield of concrete per 50 kg bag of cement, in m^3;

V = volume of concrete produced per batch, in m^3, and;

N = number of 50 kg bags of cement per batch.

4.7 Test Report

The test report shall include the following:

a) Identification of the test sample;

b) Location of performance of test;

c) Time and date of performance of test;

d) Ambient temperature;

e) Temperature of the remixed sample (optional);

f) Observations on condition of test sample (optional);

g) Any deviation from standard test method;

h) Calculated density of the fresh concrete, in kg/m^3;

j) Calculated volume of concrete per batch (when required); and

k) Calculated yield per bag of cement (when required).

ANNEX A

(*Clause* 2)

LIST OF REFERRED INDIAN STANDARDS

IS No.	*Title*	*IS No.*	*Title*
1199 (Part 1) : 2018	Fresh concrete — Methods of sampling, testing and analysis: Part 1 Sampling of fresh concrete (*first revision*)	(Part 2) : 1972	Materials (Other than cement and aggregate)
		(Part 3) : 1972	Concrete reinforcement
2505 : 1992	Concrete vibrators — Immersion type — General requirements (*third revision*)	(Part 4) : 1972	Types of concrete
		(Part 5) : 1972	Formwork for concrete
		(Part 6) : 1972	Equipment, tools and plant
2514 : 1963	Specification for concrete vibrating tables	(Part 7) : 1973	Mixing, laying, compaction, curing and other construction aspects
4845 : 1968	Definitions and terminology relating to hydraulic cement	(Part 8) : 1973	Properties of concrete
		(Part 9) : 1973	Structural aspects
6461	Glossary of terms relating to cement concrete	(Part 10) : 1973	Tests and testing apparatus
		(Part 11) : 1973	Prestressed concrete
(Part 1) : 1972	Concrete aggregates	(Part 12) : 1973	Miscellaneous

ANNEX B

(*Clauses* 4.2.1*and* 4.4.5)

CALIBRATION OF CONTAINERS FOR THE DENSITY TEST

B-1 APPARATUS

B-1.1 Scales or Balance — It shall be capable of weighing the container either empty or full of water to an accuracy of 0.1percent.

B-1.2 Glass Plate — Circular or square plate with a minimum thickness of 5 mm, and it shall extend 25 mm on each side.

B-2 PROCEDURE

Weigh the empty container and glass plate to an accuracy of 0.1 percent and record the indicated mass.

Place the container on a horizontal surface and fill with water at a temperature of 27 ± 2°C. The container shall be filled to overflowing level and glass plate slid over it to exclude any air bubbles. Remove any excess water from the outside of the container plate.

Weigh the container, glass plate and water to an accuracy of 0.1 percent and record the indicated mass.

Calculate the volume of the container by dividing the total mass, expressed in kilograms, of water required to fill the container by 996.5.

Express the volume, V, expressed in cubic metres of the container to an accuracy of 0.1 percent.

B-3 CALIBRATION INTERVAL

The container shall be calibrated before initial use and at least annually thereafter. It is recommended that the balance be calibrated at least annually. The frequency may be increased based on usage or repair.

ANNEX C

(*Foreword*)

COMMITTEE COMPOSITION

Cement and Concrete Sectional Committee, CED 02

Organization	*Representative(s)*
In Personal Capacity (*14A, Summer Breeze, Kuravankonam, Kowdiar, Thiruvananthapuram 695 003*)	Shri Jose Kurian (***Chairman***)
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CSIR – Central Building Research Institute, Roorkee	Shri S. K. Singh Shri Subhash Gurram (*Alternate*)
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CSIR – Structural Engineering Research Centre, Chennai	Dr K. Ramanjaneyulu Dr P. Srinivasan (*Alternate*)
Central Soil and Materials Research Station, New Delhi	Director Shri N. Siva Kumar (*Alternate*)
Central Water Commission, New Delhi	Director (CMDD) (N&W) Deputy Director (CMDD) (NW&S) (*Alternate)*
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Indian Association of Structural Engineers, New Delhi	Shri Mahesh Tandon Shri Ganesh Juneja (*Alternate*)
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(*Continued from second cover*)

In the formulation of this standard, assistance has also been derived from ISO 1920-2 : 2016, 'Testing of concrete — Part 2: Properties of fresh concrete'.

The composition of the Committee responsible for the formulation of this standard is given in Annex C.

In reporting the result of a test or analysis made in accordance with this standard, if the final value observed or calculated, is to be rounded off, it shall be done in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'.

Bureau of Indian Standards

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Review of Indian Standards

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